

Notice No.8

Rules and Regulations for the Classification of Naval Ships, January 2019

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Please note that corrigenda amends to paragraphs, Tables and Figures are not shown in their entirety.

Issue date: November 2019

Amendments to	Effective date	IACS/IMO implementation (if applicable)
Volume 1, Part 4, Chapter 3, Section 2	Corrigendum	NA
Volume 1, Part 5, Chapter 3, Sections 2 & 4	Corrigenda	NA
Volume 1, Part 6, Chapter 2, Section 3	Corrigendum	NA
Volume 1, Part 6, Chapter 3, Sections 3 & 15	Corrigenda	NA
Volume 2, Part 8, Chapter 1, Sections 1-12, 14 & 15	Corrigenda	NA
Volume 2, Part 8, Chapter 2, Sections 1-7, 10 & 11	Corrigenda	NA
Volume 2, Part 11, Chapter 2, Section 3	Corrigenda	NA

Volume 1, Part 4, Chapter 3

Special Features

Section 2

Vehicle decks and fixed ramps

2.3 Deck plating

2.3.1 The thickness, t_p , of vehicle deck plating is to be taken as not less than:

$$t_p = \frac{\alpha s}{1000 \sqrt{k_s}} \text{ mm}$$

where

β = tyre print coefficient used in *Figure 3.2.1 Tyre point chart*

$$= \log_{10} \left(\frac{F_{typ} K_{s2}}{9,81 s^2} \right) \times 10^7 \quad 10^7 \quad \log_{10} \left(\frac{F_{typ} K_{s2}}{9,81 s^2} \times 10^7 \right)$$

Volume 1, Part 5, Chapter 3

Local Design Loads

Section 2

Motion response

2.4 Design vertical acceleration for ships in the planning regime

Table 3.2.1 Ship motions

Motion			Acceleration
Pitch		a_{pitch}	$= a_0 \left(5,3 - \frac{45}{L_{WL}} \right) \left(\frac{x_{wl} - L_{CG}}{L_{WL}} \right) \left(\frac{0,6}{C_b} \right)^{0,75}$ $= a_0 \left(5,3 - \frac{45}{L_{WL}} \right) \left(\frac{x_{wl} - L_{CG}}{L_{WL}} \right) \left(\frac{0,6}{C_b} \right)^{0,75}$
Roll	Acceleration due to Roll Vertical direction	a_{roll}	$= a_0 \frac{0,6_y K^{1,5}}{B_{WL}}$ $= a_0 \frac{0,6_y K^{1,5}}{B_{WL}}$
Relative vertical motion		H_{rm}	$= C_{w, \min} \left(1 + \frac{k_r}{(C_b + 0,2)} \left(\frac{x_{wl}}{L_{WL}} - x_m \right)^2 \right)$ $= C_{w, \min} \left(1 + \frac{k_r}{(C_b + 0,2)} \left(\frac{x_{wl}}{L_{WL}} - x_m \right)^2 \right)$
Symbols			
	$C_w = \text{a wave head, in metres}$ $= f_{HS} 0,0771 L_{WL} (C_b + 0,2)^{0,3} e^{(-0,0044 L_{WL})}$ $= f_{HS} 0,0771 L_{WL} (C_b + 0,2)^{0,3} e^{(-0,0044 L_{WL})}$		
	$K_m = 1 + \frac{k_r (0,5 - x_m)^2}{(C_b + 0,2)}$ $1 + \frac{k_r (0,5 - x_m)^2}{(C_b + 0,2)}$		

■ Section 4

Impact loads on external plating

4.3 Bow flare and wave impact pressures, IP_{bf}

4.3.1 This Section is applicable to:

- Bow flare region.
- Sides and undersides of sponsons.
- Other parts of the side shell plating close to and above the design waterline that are expected to be subjected to wave impact pressures.

The bow flare wave impact pressure, wave impact pressure on sponsons and other parts of the side shell plating above the design waterline, IP_{bf} , in kN/m^2 , due to relative motion is to be taken as:

V_{bf} = wave impact velocity, in m/s, and is given by

$$\sqrt{V_{th} + 2m_1 \ln(N_{bf})} \text{ for } N_{bf} \geq 1 \text{ for } N_{bf} \geq 1 \quad \sqrt{V_{thbf}^2 + 2m_1 \ln(N_{bf})} \text{ for } N_{bf} \geq 1$$

Volume 1, Part 6, Chapter 2

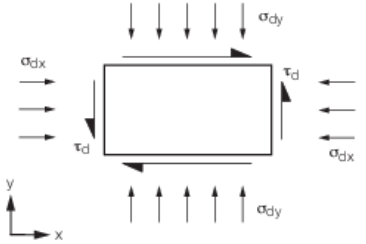
Design Tools

■ Section 3

Buckling

3.3 Plate panel buckling requirements

Table 2.3.1 Plate panel buckling requirements

	Stress field	Buckling interaction formula	
(e)	bi-axial compressive loads plus shear loads	$0,25 \frac{\left(1 + \frac{0,6}{A_R}\right) \left(\frac{\sigma_{dy}}{\sigma_{cy}}\right) + \left(\frac{\tau_d}{\tau_c}\right)^2}{1 - 0,625 \left(\frac{\sigma_{dx}}{\sigma_{cx}}\right)} \leq 1$ $\frac{0,625 \left(1 + \frac{0,6}{A_R}\right) \left(\frac{\sigma_{dy}}{\sigma_{cy}}\right) + \left(\frac{\tau_d}{\tau_c}\right)^2}{1 - 0,625 \left(\frac{\sigma_{dx}}{\sigma_{cx}}\right)} \leq 1$	

Volume 1, Part 6, Chapter 3

Scantling Determination

■ Section 3

NS1 scantling determination

3.9 Shell envelope plating

Table 3.3.1 Shell envelope plating

Symbols
$S_b = 700mm \ 0,95LR \text{ to } 0,7LR \ 0,05LR$ $= 700mm \ 0,7LR \text{ to } 0,05LR$

■ Section 15 Strengthening for wave impact loads above waterline

15.2 Strengthening against bow flare wave impacts

15.2.6 The effective section properties of secondary stiffeners are to be taken as:

(a) Plastic section modulus of secondary stiffeners, Z_p is to be taken as:

$$Z_p = (2,8 \times 10^{-4} S_{cm} t_p^2) - (10^{-3} b_f b_{fc} t_f \sin \theta_e) + (5 \times 10^{-4} (h_w^2 t_w + 2b_f t_f h_w) \cos \theta_e) \text{ cm}^3$$

where

$$b_{fc} = 0,5(b_f - t_w) \text{ for L profiles}$$

$$= 0 \text{ for flat bar and T profiles}$$

$$= \frac{c}{2}, \text{ see Figure 2.2.1 Dimensions of longitudinals in Chapter 2, for bulb profiles for c}$$

Volume 2, Part 8, Chapter 1 Steam Raising Plant and Associated Pressure Vessels

■ Section 1 General requirements

1.2 Definitions of symbols

1.2.1 The symbols used in the various formulae in Vol 2, Pt 8, Ch 1, 2 *Cylindrical shells and drums subject to internal pressure*, unless otherwise stated, are defined as follows and are applicable to the specific part of the pressure vessel under consideration:

p = design pressure, see Vol 2, Pt 8, Ch 1, 1.3 *Design pressure*, in bar MPa

1.5 Classification of fusion welded pressure vessels

1.5.1 For Rule purposes, pressure vessels with fusion welded seams are graded as Class 1 if they comply with the following conditions:

- (a) For pressure parts of fired steam boilers, fired thermal liquid heaters and exhaust gas heated shell type steam boilers where the design pressure exceeds 3,4 bar 0,34 MPa.
- (b) For pressure parts of steam heated steam generators and separate steam receivers where the design pressure exceeds 11,3 bar 1,13 MPa, or where the pressure, in bar MPa, multiplied by the internal diameter of the shell, in mm, exceeds 14 420 1442.

■ Section 2 Cylindrical shells and drums subject to internal pressure

2.1 Minimum thickness

2.1.1 Minimum thickness, t , of a cylindrical shell is to be determined by the following formula:

$$t = \frac{pR_i}{10\sigma J - 0,5p} + 0,75 \text{ mm} \quad t = \frac{pR_i}{\sigma J - 0,5p} + 0,75 \text{ mm}$$

2.4 Unreinforced openings

2.4.2 The maximum diameter, d , of any unreinforced isolated openings is to be determined by the following formula:

$$d = 8,08[D_o t(1 - K)]^{1/3} \text{ in mm} \quad d = 8,08[D_o t(1 - K)]^{1/3} \text{ in mm}$$

The value of K to be used is calculated from the following formula:

$$K = \frac{pD_o}{18,2\sigma t} \text{ but is not to be taken as greater than } 0,99 \quad K = \frac{pD_o}{1,82\sigma t} \text{ but is not to be taken as greater than } 0,99$$

■ Section 3 Spherical shells subject to internal pressure

3.1 Minimum thickness

3.1.1 The minimum thickness of a spherical shell is to be determined by the following formula:

$$t = \frac{pR_i}{20\sigma J - 0,5p} + 0,75 \text{ mm} \quad t = \frac{pR_i}{2\sigma J - 0,5p} + 0,75 \text{ mm}$$

■ Section 4 Dished ends subject to internal pressure

4.1 Minimum thickness

4.1.1 The thickness, t , of semi-ellipsoidal and hemispherical unstayed ends, and the knuckle section of torispherical ends, dished from plate, having pressure on the concave side and satisfying the conditions listed below, is to be determined by the following formula:

$$t = \frac{pD_o K}{20\sigma J} + 0,75 \text{ mm} \quad t = \frac{pD_o K}{2\alpha J} + 0,75 \text{ mm}$$

4.1.4 In addition to the formula in Vol 2, Pt 8, Ch 1, 4.1 Minimum thickness 4.1.1 the thickness, t , of a torispherical head, made from more than one plate, in the crown section is to be not less than that determined by the following formula:

$$t = \frac{pR_i}{20\sigma J - 0,5p} + 0,75 \text{ mm} \quad t = \frac{pR_i}{2\sigma J - 0,5p} + 0,75 \text{ mm}$$

■ Section 5 Conical ends subject to internal pressure

5.2 Minimum thickness

5.2.1 The minimum thickness, t , of cylinder, knuckle and conical section at the junction and within the distance, L , from the junction is to be determined by the following formula:

$$t = \frac{pD_o K}{20\sigma J} + 0,75 \text{ mm} \quad t = \frac{pD_o K}{2\sigma J} + 0,75 \text{ mm}$$

5.2.3 The minimum thickness, t , of those parts of conical sections not less than a distance, L , from the junction with a cylinder or other conical section is to be determined by the following formula:

$$t = \frac{pD_c}{(20\sigma J - p) \cos \alpha} + 0,75 \text{ mm} \quad t = \frac{pD_c}{(2\sigma J - p) \cos \alpha} + 0,75 \text{ mm}$$

■ Section 6 Standpipes and branches

6.1 Minimum thickness

6.1.2 For boilers having a working pressure exceeding ~~50 bar~~ 5 MPa and safety valves of full lift or full bore type, the thickness of the branch pipe carrying the superheater or drum safety valves is to be not less than:

■ Section 7 Boiler tubes subject to internal pressure

7.1 Minimum thickness

7.1.1 The minimum wall thickness of straight tubes subject to internal pressure is to be determined by the following formula:

$$t = \frac{pD_o}{20\sigma + p} + 1 \text{ mm} \quad t = \frac{pD_o}{2\sigma + p} \text{ mm}$$

■ Section 8 Headers

8.2 Rectangular section headers

8.2.1 The thickness of the flat walls of rectangular section headers is to be determined at the centre of the sides, at all the lines of holes and at the corners. The minimum required shall be the greatest thickness determined by the following formula:

$$t = \frac{pn}{20\sigma J} + \sqrt{\frac{0,4Y_p}{\sigma J_1}} + 0,75 \text{ mm} \quad t = \frac{pn}{2\sigma J} + \sqrt{\frac{4Y_p}{\sigma J_1}} + 0,75 \text{ mm}$$

8.4 Header ends

8.4.3 Ends attached by welding are to be designed as follows:

Flat ends: the minimum thickness of flat end plates is to be determined by the following formula:

$$t = d_i \sqrt{\frac{pC}{\sigma}} + 0,75 \text{ mm} \quad t = d_i \sqrt{\frac{10pC}{\sigma}} + 0,75 \text{ mm}$$

■ Section 9 Flat surfaces and flat tube plates

9.1 Stayed flat surfaces

9.1.6 The thickness, t , of those portions of flat plates supported by stays and around tube nests is to be determined by the following formula:

$$t = Cd \sqrt{\frac{p}{\sigma}} + 0,75 \text{ mm} \quad t = Cd \sqrt{\frac{10p}{\sigma}} + 0,75 \text{ mm}$$

9.2 Combustion chamber tube plates under compression

9.2.1 The thickness of combustion chamber tube plates under compression due to the pressure on the top plate, based on a compressive stress not exceeding 96 N/mm² is to be determined by the following formula:

$$t = \frac{pWs}{1930(s-d)} \text{ mm} \quad t = \frac{pWs}{193(s-d)} \text{ mm}$$

9.3 Girders for combustion chamber top plates

9.3.2 The thickness of steel plate girders supporting the tops of combustion chambers is to be determined by the following formula:

$$t = \frac{0,32pl^2s}{d^2R_{20}} + 0,75 \text{ mm} \quad t = \frac{3,2pl^2s}{d^2R_{20}} + 0,75 \text{ mm}$$

9.4 Flat plate margins

9.4.1 The width of margin, b , of a flat plate which may be regarded as being supported by the shell, furnaces or flues to which the flat plate is attached is not to exceed that determined by the following formula:

$$b = C(t - 0,75) \sqrt{\frac{\sigma}{p}} \text{ mm} \quad b = C(t - 0,75) \sqrt{\frac{\sigma}{10p}} \text{ mm}$$

9.4.5 In no case is the diameter D , in mm, of the circle forming the boundary of the margin supported by the uptake of a vertical boiler to be greater than determined by the following formula:

$$D = \sqrt{\frac{34,5A}{p} + d^2} \quad D = \sqrt{\frac{34,5A}{p} + d^2}$$

■ Section 10 Flat plates and ends of vertical boilers

10.1 Tube plates of vertical boilers

10.1.1 Where vertical boilers have a nest or nests of horizontal tubes, so that there is direct tension on the tube plates due to the vertical load on the boiler ends or to their acting as horizontal ties across the shell, the thickness of the tube plates in way of the outer rows of tubes is to be determined by the following formula:

$$t = \frac{pD}{5J R_{20}} + 0,75 \text{ mm} \quad t = \frac{pD}{0,5J R_{20}} + 0,75 \text{ mm}$$

10.2 Horizontal shelves of tube plates forming part of the shell

10.2.1 For vertical boilers of the type referred to in *Vol 2, Pt 8, Ch 1, 10.1 Tube plates of vertical boilers*, in order to withstand vertical load due to pressure on the boiler ends, the horizontal shelves of the tube plates are to be supported by gussets in accordance with the following formula:

$$C = \frac{AD_1p}{t} \quad C = \frac{10AD_1p}{t}$$

where

p = design pressure, in ~~bar~~ MPa

10.3 Dished and flanged ends for vertical boilers

10.3.1 The minimum thickness, t , of dished and flanged ends for vertical boilers which are subject to pressure on the concave side and are supported by central uptakes is to be determined by the following formula:

$$t = \frac{pR_1}{13\sigma} + 0,75 \text{ mm} \quad t = \frac{pR_1}{1,3\sigma} + 0,75 \text{ mm}$$

■ Section 11 Furnaces subject to external pressure

11.2 Corrugated furnaces

11.2.1 The minimum thickness, t , of corrugated furnaces is to be determined by the following formula:

$$t = \frac{pD_o}{c} \quad t = \frac{10pD_o}{c}$$

11.3 Plain furnaces, flue sections and combustion chamber bottoms

11.3.1 The minimum thickness, t , between points of substantial support, of plain furnaces or furnaces strengthened by stiffening rings, of flue sections and of the cylindrical bottoms of combustion chambers is to be determined by the following formulae, the greater of the two thicknesses obtained being taken:

$$t = \frac{pD_o(L+610)}{102\,400} + 0,75 \text{ mm} \quad t = \frac{pD_o(L+610)}{102\,40} + 0,75 \text{ mm}$$

$$t = \frac{CpD_o}{1100} + \frac{L}{320} + 0,75 \text{ mm} \quad t = \frac{CpD_o}{110} + \frac{L}{320} + 0,75 \text{ mm}$$

11.3.2 Where stiffeners are used for strengthening plain cylindrical furnaces, or combustion chambers, the second moment of area, I , of the stiffener is to be determined by the following formula:

$$I = \frac{pD_o^3 L}{13,3 \times 10^6} \text{ mm}^4 \quad I = \frac{pD_o^3 L}{13,3 \times 10^5} \text{ mm}^4$$

11.5 Hemispherical furnaces

11.5.1 The minimum thickness, t , of unsupported hemispherical furnaces subject to pressure on the convex surface is to be determined by the following formula:

$$t = \frac{CpR_o}{608} + 0,75 \text{ mm} \quad t = \frac{CpR_o}{60,8} + 0,75 \text{ mm}$$

11.6 Dished and flanged ends for supported vertical boiler furnaces

11.6.1 The minimum thickness, t , of dished and flanged ends for vertical boiler furnaces that are subject to pressure on the convex side and are supported by central uptakes, is to be determined by the following formula:

$$t = \frac{pR_o}{10\sigma} + 0,75 \text{ mm} \quad t = \frac{pR_o}{\sigma} + 0,75 \text{ mm}$$

11.7 Dished and flanged ends for unsupported vertical boiler furnaces

11.7.1 The minimum thickness, t , of dished and flanged ends for vertical boiler furnaces that are subject to pressure on the convex side and are without support from stays of any kind, is to be determined by the following formula, but is in no case to be less than the thickness of the firebox:

$$t = \frac{CpR_o}{660} + 0,75 \text{ mm} \quad t = \frac{CpR_o}{66} + 0,75 \text{ mm}$$

11.8 Ogee rings

11.8.1 The minimum thickness, t , of the ogee ring which connects the bottom of the furnace to the shell of a vertical boiler and sustains the whole vertical load on the furnace is to be determined by the following formula:

$$t = \sqrt{\frac{pD_i(D_i-D_o)}{9900}} + 0,75 \text{ mm} \quad t = \sqrt{\frac{pD_i(D_i-D_o)}{990}} + 0,75 \text{ mm}$$

11.9 Uptakes of vertical boilers

11.9.1 The minimum thickness, t , of internal uptakes of vertical boilers is to be determined by the following formulae, the greater of the two thicknesses obtained being taken:

$$t = \sqrt{\frac{pD_o(L+610)}{102\,400}} + 4 \text{ mm} \quad t = \sqrt{\frac{pD_o(L+610)}{102\,40}} + 4 \text{ mm}$$

$$t = \frac{pD_o}{1100} + \frac{L}{320} + 4 \text{ mm} \quad t = \frac{pD_o}{110} + \frac{L}{320} + 4 \text{ mm}$$

■ Section 12 Boiler tubes subject to external pressure

12.1 Tubes

Table 1.12.1 Thickness of plain tubes under external pressure

Design pressure, in bar MPa											Thickness, in mm
Outside diameter, in mm											
38	44,5	51	57	63,5	70	76	82,5	89	95	102	5,89
—	—	—	—	—	—	—	—	—	26,9 2,69	25,2 2,52	

–	–	–	–	–	–	–	26,2 2,62	24,1 2,41	22,8 2,28	21,4 2,14	5,38
–	–	–	–	–	–	24,1	22,1	20,7	19,3	17,9	4,88
–	–	–	27,6 2,76	24,8 2,48	22,8 2,28	20,7 2,07	19,3 1,93	17,9 1,79	16,6 1,66	15,9 1,59	4,47
–	29,3 2,93	25,5 2,55	22,8 2,28	20,7 2,07	18,9 1,89	17,3 1,73	15,9 1,59	14,8 1,48	13,7 1,37	12,7 1,27	4,06
26,6 2,66	22,8 2,28	20,7 2,07	17,9 1,79	15,9 1,59	14,8 1,48	13,1 1,31	12,4 1,24	11,4 1,14	10,3 1,03	9,6 0,96	3,66
20,3 2,03	16,9 1,69	14,8 1,48	13,1 1,31	12,1 1,21	11,0 1,10	9,6 0,96	8,9 0,89	8,2 0,82	7,6 0,76	6,9 0,69	3,25
14,8 1,48	12,4 1,24	10,7 1,07	9,6 0,96	8,6 0,86	7,6 0,76	–	–	–	–	–	2,95

■ Section 14 Construction

14.1 Access arrangements

14.1.10 Circular flat cover plates may be fitted to raised circular manhole frames not exceeding 400 mm diameter, and for an approved design pressure not exceeding ~~18 bar~~ 1,8 MPa.

■ Section 15 Mountings and fittings for cylindrical and vertical boilers, steam generators, pressurised thermal liquid and pressurised hot waters

15.1 General

15.1.4 Safety valve chests and other boiler and superheater mountings subjected to pressures exceeding ~~13,0 bar~~ 1,3 MPa or to steam temperatures exceeding 220°C, and boiler blow-down fittings, are to be made of steel or other approved material.

15.2 Safety valves

15.2.11 The designed discharge capacities of the safety valves on each boiler and steam generator are to be found from the following formulae:

(a) Saturated steam safety valves:

$$E = \frac{AC(p+1,03)}{98,1} \quad E = \frac{AC(10p+1,03)}{98,1}$$

Superheated steam safety valves:

$$E = \frac{AC(p+1,03)}{98,1} \sqrt{\frac{V_s}{V_H}} \quad E = \frac{AC(10p+1,03)}{98,1} \sqrt{\frac{V_s}{V_H}}$$

where

p = set pressure, in ~~bar gauge~~ MPa

15.3 Waste steam pipes

15.3.4 The scantlings of waste steam pipes and silencers are to be suitable for the maximum pressure to which the pipes may be subjected in service, and in any case not less than ~~10 bar~~ 1 MPa.

Volume 2, Part 8, Chapter 2 Other Pressure Vessels

■ Section 1 General requirements

1.2 Definitions of symbols

1.2.1 The symbols used in the various formulae in ~~Sections~~ Vol 2, Pt 8, Ch 2, 2 Cylindrical shells and drums subject to internal pressure, unless otherwise stated, are defined as follows, and are applicable to the specific part of the pressure vessel under consideration:

p = design pressure, see Vol 2, Pt 8, Ch 2, 1.3 Design pressure, in ~~bar~~ MPa

1.5 Classification of fusion welded pressure vessels

1.5.2 For Rule purposes, pressure vessels are graded as Class 2/1 and Class 2/2 if they comply with the following conditions:

- (a) where the design pressure exceeds ~~17,2 bar~~ 1,72 MPa; or
- (c) where the design pressure, in ~~bar~~ MPa, multiplied by the actual thickness of the shell, in mm, exceeds ~~157~~ 15,7; or

1.6 Plans

1.6.1 Plans of pressure vessels are to be submitted in triplicate for consideration where all the conditions in (a) or (b) are satisfied:

- (a) The vessel contains vapours or gases, e.g. air receivers, hydrophore or similar vessels and gaseous CO₂ vessels for fire-fighting, and

$$p_v > 600 \text{ 60}$$

$$p > 1,1$$

$$V > 100$$

V = volume (litres) of gas or vapour space

- (b) The vessel contains liquefied gases, or flammable liquids

$$p > 7,7$$

$$V > 100$$

V = volume (litres)

p is as defined in Vol 2, Pt 8, Ch 2, 1.2 Definition of symbols 1.2.1

■ Section 2 Cylindrical shells and drums subject to internal pressure

2.1 Minimum thickness

2.1.1 The minimum thickness, t , of a cylindrical shell is to be determined by the following formula:

$$t = \frac{pR_i}{10\sigma_j - 0,5p} + 0,75 \text{ mm} \quad t = \frac{pR_i}{\sigma_j - 0,5p} + 0,75 \text{ mm}$$

■ Section 3 Spherical shells subject to internal pressure

3.1 Minimum thickness

3.1.1 The minimum thickness, t , of a spherical shell is to be determined by the following formula:

$$t = \frac{pR_i}{20\sigma_j + 0,5p} + 0,75 \text{ mm} \quad t = \frac{pR_i}{2\sigma_j + 0,5p} + 0,75 \text{ mm}$$

■ Section 4 Dished ends subject to internal pressure

4.1 Minimum thickness

4.1.1 The thickness, t , of semi-ellipsoidal, and hemispherical unstayed ends, and the knuckle section of torispherical ends dished from plate, having pressure on the concave side and satisfying the conditions listed below, is to be determined by the following formula:

$$t = \frac{pD_oK}{20\sigma_j} + 0,75 \text{ mm} \quad t = \frac{pD_oK}{2\sigma_j} + 0,75 \text{ mm}$$

4.1.4 In addition to the formula in Vol 2, Pt 8, Ch 2, 4.1 Minimum thickness 4.1.1 the thickness, t , of a torispherical head made from more than one plate, in the crown section, is to be not less than that determined by the following formula:

$$t = \frac{pR_i}{20\sigma_j - 0,5p} + 0,75 \text{ mm} \quad t = \frac{pR_i}{2\sigma_j - 0,5p} + 0,75 \text{ mm}$$

■ Section 5 Dished ends for Class 3 pressure vessels

5.1 Minimum thickness

5.1.1 As an alternative to the formula in Vol 2, Pt 8, Ch 2, 4.1 Minimum thickness 4.1.1, for Class 3 vessels only, the minimum thickness, t , of a torispherical unstayed end dished from plate and having pressure on the concave or convex side is to be determined by the following formula:

$$t = \frac{pR_i}{CS} \quad t = \frac{10pR_i}{CS}$$

■ Section 6 Conical ends subject to internal pressure

6.2 Minimum thickness

6.2.1 The minimum thickness, t , of the cylinder, knuckle and conical section at the junction and within the distance L from the junction is to be determined by the following formula:

$$t = \frac{pD_o K}{20\sigma J} + 0,75 \text{ mm} \quad t = \frac{pD_o K}{2\sigma J} + 0,75 \text{ mm}$$

6.2.3 The minimum thickness, t , of those parts of conical sections not less than a distance L from the junction with a cylinder or other conical section, is to be determined by the following formula:

$$t = \frac{pD_c}{20\sigma J - p \cos \alpha} + 0,75 \text{ mm} \quad t = \frac{pD_c}{2\sigma J - p \cos \alpha} + 0,75 \text{ mm}$$

■ Section 7 Standpipes and branches

7.1 Minimum thickness

7.1.1 The minimum wall thickness, t , of standpipes and branches is to be not less than the greater of the two values determined by the following formulae, making such additions as may be necessary on account of bending, static loads and vibrations:

$$t = \frac{pD_o}{20\sigma + p} + 0,75 \text{ mm} \quad t = \frac{pD_o}{2\sigma + p} + 0,75 \text{ mm}$$

■ Section 10 Hydraulic tests

10.1 General

10.1.1 Pressure vessels covered by this Chapter are to be tested on completion to a pressure, p_T , determined by the following formula, without showing signs of weakness or defect:

$$p_T = 1,3 \frac{\sigma_{50}}{\sigma_T} \frac{t}{(t - 0,75)} p$$

but in no case is to exceed

$$= 1,5 \frac{t}{(t - 0,75)} p$$

where

p = design pressure, in bar MPa

p_T = test pressure, in bar MPa

■ Section 11 Plate heat exchangers

11.1 General

11.1.1 Plate heat exchangers are to be classed as follows.

Class 2 where either of the following conditions apply:

(b) design pressure is ~~17,2 bar~~ 1,72 MPa or greater.

Volume 2, Part 11, Chapter 1 Made and Fresh Water Systems

■ Section 3 System arrangements

3.1 Water storage facilities

3.1.2 At least two storage tanks are to be fitted, each with separate means of supplying the fresh water distribution main. The tanks are to be ~~spacially~~ spatially separated and in NS1 and NS2 type ships at least one of the tanks is to be sited other than in the double bottom space. The tanks are to be sited and be of such dimensions that they are readily accessible to facilitate inspection, cleaning and coating.

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